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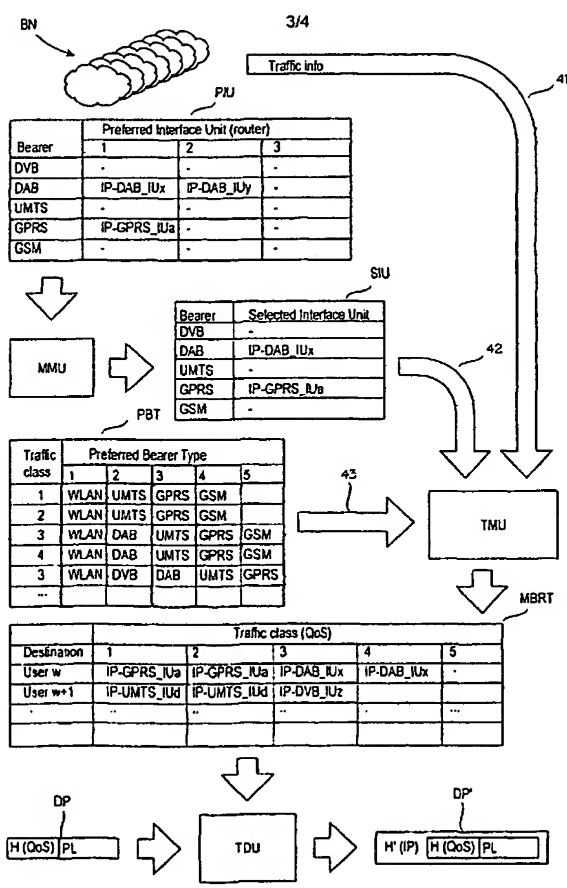
(54) Title: PACKET ROUTING IN A MULTI-BEARER-TYPE NETWORK



(57) Abstract: A method for sending a data packet (DP), which directly or indirectly indicates a quality-of-service requirement (QoS), to a mobile node (MN) from a correspondent node (MCN) via a multi-bearer network, or MBN, which provides at least one interface unit (IU) to each of multiple alternative bearer networks (BN) between the MBN and the mobile node. The method comprises selecting an optimal bearer network (BN) for sending a data packet (DP) between the MBN and the mobile node (MN) based on 1) the quality-of-service requirement (QoS) of the data packet (DP) in question; 2) traffic data load data (41) related to the multiple bearers; 3) interface unit preference information (PIU, 42); and 4) bearer type preference information (PBT, 43).

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PACKET ROUTING IN A MULTI-BEARER-TYPE NETWORK

BACKGROUND OF THE INVENTION

The invention relates to traffic management in a multi-bearer packet data network. A multi-bearer network, or an MBN, is a network having the capability to carry a data packet via one of several alternative bearers. To be more precise, the term 'multi-bearer network' should be interpreted as meaning 'multi-bearer-type network', or in other words, a network arrangement which provides multiple different bearer types for data packet delivery. An example of a suitable MBN is a concept known as MEMO (Multimedia Environment for Mobiles), see reference 1. Additionally, the MBN supports mobility of a subscriber terminal. An example of terminal mobility is IP mobility, which is the topic of standard RFC2002 by the Internet Engineering Task Force (IETF). This RFC standard is incorporated herein by reference.

The problem underlying the invention is how to select the optimal bearer for each data packet in varying situations in a multi-bearer network. Data packets have different quality-of-service requirements. Situations may vary because the subscriber moves or the network load changes.

BRIEF SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide a mechanism for selecting the optimal bearer for each data packet in varying situations. The object is achieved by a method and equipment which are characterized by what is disclosed in the attached independent claims. Preferred embodiments of the invention are disclosed in the attached dependent claims. The invention is based on the idea that selecting the optimal bearer for a data packet between the MBN and the mobile node is based on a combination of 1) the quality-of-service requirement (traffic class) of the data packet in question, 2) the mobility data related to the mobile node, 3) the traffic data related to the multiple bearers, and 4) bearer preference information. The bearer preference information can be obtained from the mobile node, and optionally, from the operators of the home and visited MBN operators.

In order to save the battery of a portable mobile node, it is preferable that the mobile node only monitors one bearer type (network) at a time. For example, the subscriber data related to the mobile node can include a default bearer type, such as GSM or UMTS. The mobile node should be paged on this bearer. The mobile node can be ordered to monitor the selected

bearer type by sending a modified page message which indicates the selected bearer type, channel, possible decryption data, etc. Alternatively, such information can be sent in a separate message, such as a short message, USSD, (Unstructured Supplementary Service Data), data call or the like.

According to another preferred embodiment of the invention, as long as the mobile node is within a certain coverage area, all IP packets belonging to the same session (or flow if flow labels are used) are routed via the same interface unit. For example, if a mobile node is receiving IP packets from a DAB network, via a cell x, all IP packets of the same session should be routed via DAB cell x, unless the mobile node moves out of the coverage area of this cell.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

The method and the apparatus according to the invention will be described in more detail by means of preferred embodiments with reference to the appended drawing in which:

Figure 1A shows a preferred structure of a network arrangement in which the invention can be used and the available options for mobile node-terminated (downlink) traffic;

Figure 1B shows the available options for mobile node-originated (uplink) traffic;

Figure 2 shows the major functional blocks of a visitor administration system according to the invention;

Figures 3A and 3B show the internal structure of the visitor administration system VAS in more detail;

Figure 4 illustrates the cooperation between a traffic management unit TMU and a traffic distribution unit; and

Figure 5 shows a preferred feature of the invention which relates to broadcast networks; and

Figure 6 shows a preferred version of a routing table with two optional fields.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1A shows a preferred structure of a network arrangement in which the invention can be used. A mobile node MN communicates with its correspondent node MCN via a multi-bearer network MBN which offers several alternative bearers for a data packet DP. Each data packet comprises a

header H and a payload part PL. To be precise, a data packet typically has several headers inside each other, because each protocol layer inserts its own header. However, each protocol layer only handles each own header, and a model with only one network layer header is usually sufficient for describing the invention. The header indicates, directly or indirectly, a quality-of-service requirement QoS for the data packet. An example of a direct QoS indication is a case where the data packet header includes a parameter which is or which can be directly mapped to a quality-of-service requirement parameter. An example of an indirect QoS indication is a case where the header indicates a PDP (packet data protocol) context, and the PDP context in turn indicates the QoS requirement. It should be understood, that 'quality of service' is a very generic term indicating certain requested or negotiated transmission characteristics, such as bit rate, maximum delay and/or packet loss probability. Depending on the actual protocol used, quality of service is indicated by or mapped to one of the existing appropriate fields, such as the Preference field of IPv6 or the Type of Service of IPv4. The term 'traffic class' is used to refer collectively to the fields which are used to indicate the quality-of-service requirement.

In Figure 1A, it has been assumed that the MBN communicates with the MCN via the Internet. There is preferably a firewall FW at the edge of the MBN. A gateway node GW interfaces the MBN to the Internet. A backbone network BBN combines the different bearer networks BN. It may be the MBN operator's internal network. A physical example of a BBN is a high-speed local-area network or a wide-area network. A home administration system HAS is largely equivalent to a home agent in the IP mobility scheme (described in the RFC 2002). A visitor administration system VAS is a logical extension of a foreign agent in the IP mobility scheme. The MBN has access to several bearers for conveying the data packet to the mobile node MN.

The bearers include a first set of bidirectional bearers. Examples of bidirectional bearers are circuit-switched mobile networks, such as GSM (Global System for Mobile communications), and packet-switched mobile networks, such as GPRS (General Packet Radio Service), and third generation mobile networks, such as UMTS (Universal Mobile Telecommunications System), which offer both circuit-switched and packet-switched bearers. For each bidirectional bearer, there is a corresponding interface unit GSM_IU, GPRS_IU and UMTS_IU.

The bearers include a second set of unidirectional bearers. Examples of unidirectional bearers are digital audio broadcast (DAB) and digital video broadcast (DVB). For both DAB and DVB, Figure 1 shows two cells DAB_C1, DAB_C2; DVB_C1, DVB_C2, and their corresponding interface units DAB_IU1, DAB_IU2; DVB_IU1, DVB_IU2.

In the system of Figure 1, there is another difference between the first and second set of bearers. In addition to being bidirectional, the bearers of the first set are point-to-point bearers. In other words, each connection is customized to one particular recipient. In contrast, the bearers of the second set are broadcast or multicast bearers. In other words, it is not immediately apparent how a connection can be customized to individual recipients. One solution to this problem is encryption of the broadcast/multicast bearers with distribution of decryption keys only to the intended recipients.

Within the context of this application, 'uplink' means from the mobile node MN to the correspondent node MCN and 'downlink' means the inverse direction. The bold arrows in Figure 1 depict various routing options for data packets in the downlink direction. For the span 12 between the MCN and the VAS, data packets are routed directly if the IP address of the mobile node MN (or its subscriber) does not belong to the MBN network. If the IP address belongs to the MBN network, data packets are routed via the home administration system HAS. This route is drawn with a thin dotted line 11. For the span 12 between the VAS and the MN, the VAS has several alternative bearers. According to the invention, the VAS considers all of the following: 1) the quality-of-service requirement (the traffic class) of the data packet in question, 2) the mobility data related to the mobile node (i.e., which bearers and which interface units can be used to reach the MN), 3) the traffic load/resource availability data related to the multiple bearers, and 4) bearer preference information. The optimal bearer selection and the internal structure of the VAS will be described later in more detail.

Figure 1B shows the available bearer options for uplink traffic between the MN and the MCN. Because the DAB and DVB bearers are unidirectional (downlink only), they are not available for uplink traffic, and the only available bearers 21a to 21c are via the mobile networks GSM, GPRS and UMTS.

Figure 2 shows the major functional blocks of a visitor administration system VAS according to the invention. The VAS has three main functions

or sections: 1) a mobility management function MMF, 2) a traffic management function TMF, and 3) a caching proxy CP. The mobility management function MMF of the VAS is largely equivalent to a foreign agent in the IP mobility scheme of RFC 2002. The MMF may also participate in authentication and/or charging. The functions of the traffic management function TMF include a) collecting traffic information from the various bearer networks (GSM, GPRS, UMTS, DAB, DVB...), b) collecting traffic management-related information from the mobile node MN and its home MBN, c) sending traffic management-related messages to the mobile node MN, d) selecting the bearer network for downlink traffic, and e) forwarding downlink traffic to the selected bearer network. The function of the caching proxy CP is to maintain frequently-requested content in high-speed memory in order to minimize retrieval of such content over telecommunication lines. The caching proxy CP should have enough intelligence to handle data packets in an application-specific manner, instead of merely caching IP traffic packets.

Figures 3A and 3B show the internal structure of the visitor administration system VAS in more detail from the point of view of traffic management. Figure 3A shows the VAS structure from the point of view of user traffic.

IP Routing Software blocks 31 to 33 route data packets to the appropriate recipients, based on the packet headers. These blocks also decapsulate IP packets towards the VAS and pass the decapsulated packets to the upper layers for further processing. Correspondingly, the blocks 31 to 33 also encapsulate packets arriving from the upper layers. In Figures 3A and 3B, the packets from the upper layers are indicated as the traffic flow entering the blocks 31 to 33 from above. The VAS also comprises a traffic distribution unit TDU. The function of the TDU is a) to determine the traffic class of incoming IP packets based on one or more quality-of-service related parameters indicated by the packet header (these parameters may comprise 'type of service' for IPv4 and 'preference' or 'flow label' for IPv6), b) based on the traffic class/QoS requirement, to select an appropriate bearer (radio network) for downlink traffic, and c) to encapsulate each IP packet into an outer IP header towards the selected bearer network and interface unit. The fact that the arrow from the TDU enters IP routing block 32 from below indicates that the TDU has already encapsulated the IP packets, and the block 32 should not perform another encapsulation.

Figure 3B shows the VAS structure from the point of view of system traffic, mobility management and traffic management. A mobility management unit MMU performs the functions which are normally performed by a foreign agent in an IP network with mobile IP support, with some enhanced functionality related to MBN support, such as cell selection and handover control within a broadcast network or between networks. The function of the traffic management unit TMU is a) to collect traffic load information from the various bearer networks BN (DVB, DAB, UMTS, etc.), b) to collect and to update (via the MMU) bearer preference information from the mobile nodes, c) optionally to collect bearer type preference information from the home network of each mobile node, d) to create and update bearer routing information to the TDU, and e) to send traffic administrative messages to the mobile nodes. For performing these functions, the traffic management unit TMU receives the following input: a) traffic load information from the various bearer networks BN, b) bearer preference information from the mobile nodes, and c) optionally bearer type preference information from the home MBN of each mobile node. The traffic distribution unit TDU and the traffic management unit TMU cooperate to perform the traffic management function TMF shown in Figure 2. The cooperation of the TDU and the TMU will be described in more detail in connection with Figure 4.

Figure 4 illustrates the cooperation between the traffic management unit TMU and the traffic distribution unit TDU. The traffic management unit TMU considers three kinds of information: 1) traffic load information 41 from the various bearer networks BN, 2) available interface unit information 42 and 3) preferred bearer type 43. The traffic information 41 from the various bearer networks BN indicates the load (or inversely: the available capacity) on the alternative bearer networks. This information may be used as a basis for hard decisions (whether or not a requested bearer can be allocated) or for soft decisions (whether or not tariffs should be adjusted to promote the use of lightly loaded bearer networks). The available interface unit information 42 can be generated as follows. A preferred interface unit table PIU indicates for each bearer type (DVB, DAB, UMTS, GPRS and GSM) one or more preferred interface units (or to be more precise the IP addresses of the preferred interface units) and their rank of preference. The PIU table is mobile-node-specific. Each mobile node MN should directly or indirectly indicate its PIU table during registration and in connection with location updates. For example, an MN may

indicate the PIU directly by forming and sending the PIU table to the VAS. The PIU table is not sent to the TMU directly, however. Instead, the mobility management unit MMU controls handover within and between the networks. Accordingly, the MMU also selects the interface unit for each broadcast network. The MMU considers the PIU and the mobility data related to the mobile node (i.e., what interface unit can be used to reach the MN). The MMU uses this information to create an available interface unit table AIU which is then applied to the TMU (instead of the PIU table as such). The preferred bearer type information 43 can be organized as a table of a preferred bearer type PBT. The PBT table indicates, for each traffic class, several alternative bearer types with decreasing preference. The acronym 'WLAN' stands for wireless local-area network, although such a network is not shown separately in Figures 1A and 1B. For example, for traffic class 1, the most preferred bearer types are WLAN and UMTS, but GPRS and GSM are also possible choices. The VAS may obtain a home-MBN-specific PBT table in connection with MN registration, or it may use a generic default PBT table.

The traffic management unit TMU considers all the available information 41 through 43, and creates and updates a Multi-Bearer Routing Table MBRT in the traffic distribution unit TDU. The MBRT indicates the IP address of the appropriate interface unit for each combination of active user w, w+1, etc. and traffic class 1 through 5 (the number 5 being just one example). It should be noted that a user with multiple simultaneous sessions can have an entry for each session in the MBRT table. When the traffic distribution unit TDU receives a data packet whose header H indirectly indicates a traffic class (via a QoS-related parameter), the TDU uses the corresponding user ID and the traffic class to retrieve the IP address of the appropriate interface from the Multi-Bearer Routing Table MBRT. Next, the TDU encapsulates the data packet DP into another data packet DP' whose header H' indicates the IP address (of the selected interface unit) which was retrieved from the MBRT. When the selected interface unit receives the data packet DP', it decapsulates the outer header H' and sends the original data packet DP to the mobile node MN. An advantage of an MBRT table substantially as shown in Figure 4 is that it directly indicates, for each data packet, the IP address to which the packet is to be sent. In other words, sending an individual data packet involves no decision-making, just a retrieval of an IP address from the MBRT table.

For IPv6, the traffic class can be mapped to Preference. For IPv4, the traffic class can be mapped to Type of Service. If the Differentiated Services protocol is used, traffic class can be mapped to bits reserved for future use. According to a preferred embodiment of the invention, for IPv6, all packets with identical flow labels are usually mapped identically.

Let us assume that a user w has three simultaneous applications: news, FTP and video on demand. The IP packets from the MCN to this user may have a preference/priority value of 1 for news, 4 for FTP and 9 for video. The PIU and PBT tables are as shown in Figure 4 and the MBN uses five traffic classes, and the mapping between the preference value and the traffic class is as follows:

preference value	traffic class
1 - 2	1
3	2
4 - 7	3
8 - 11	4
12 - 15	5

In such a case, the IP packets carrying news belong to traffic class 1, and they are routed via the router whose IP address is IP-GPRS_IUa. The IP packets carrying FTP belong to traffic class 3, and they are routed via the router whose IP address is IP-DAB_IUx. The IP packets carrying video belong to traffic class 4, and they are routed via the router whose IP address is IP-DAB_IUx.

Let us now assume that the user w starts yet another application, such as e-mail having a preference value of 2. In this case, IP packets carrying e-mail belong to traffic class 1, and they are routed via the router whose IP address is IP-GPRS_IUa.

Figure 5 shows yet another preferred feature or addition to the embodiment shown in Figure 4. This preferred feature allows paging the mobile node via a single default bearer and using a single interface unit as long as the mobile node is within its coverage area. The feature is based on the idea that IP packets separated by a time interval exceeding a certain maximum time T_{max} are treated by the MBN as belonging to two separate sessions. In this case, each entry in the MBRT table includes not only the IP address of the

relevant interface unit but also a busy flag B and a timer field T. The timer field T is compared with the maximum value T_{max}, the value of which is optimized by the operator. If the busy flag B is zero, it means that no IP packets used this entry for the past time interval of T_{max}. If the busy flag B is set (indicated in Figure 6 with 'B=1'), it means that at least one IP packet used this entry for the past time interval of T_{max}. The value of each timer field T is incremented by the TMU in a constant time interval. Each time an IP packet is routed by using a certain entry in the MBRT table, the corresponding timer field T of that entry is reset to zero and the busy flag is set to one. Setting the busy flag to '1' is preferably performed or triggered by the TDU when it routes an IP packet.

Figure 6 shows a way to use the B and T fields shown in Figure 5. In step 61, the traffic distribution unit TDU examines the header of an incoming IP packet. The TDU determines the destination IP address and traffic class (direct or indirect mapping) and retrieves the corresponding entry from the MBRT table. In step 62, the TDU checks the busy flag B to see if the selected interface unit IU has been used by this user/session during the last time interval T_{max}. If not, then in step 63 the TDU begins to buffer incoming IP packets and in step 64 the TDU pages the mobile node. More preferably, to reduce the computational load of the TDU, the TDU can only trigger a page while the actual page operation is performed by another unit, such as the TMU. In step 65, when the page operation is complete and the mobile node responds, the busy flag T is set to one and the timer field T is initialized to zero. In step 66, the TDU begins encapsulating each original IP packet with another IP header whose destination IP address is retrieved from the MBRT table. Finally, in step 67, the encapsulated IP packets are delivered via the IP routing software to the mobile node.

The traffic management unit TMU is responsible for updating the MBRT. The MBRT updating should obey the following principles. An entry of the MBRT table, or more specifically, the IP address for a certain combination of a user/session and a traffic class, can only be modified under the following circumstances: If the busy flag B is zero, the IP address can be updated if a) the modification is caused by a handover between cells of a broadcast network or between different networks, b) the mobile node moves out of the coverage area of one bearer, or c) the traffic load/resource availability changes. On the other hand, if the busy flag B is zero, the IP address can be updated if a) the modification is caused by a handover between cells of a broadcast net-

work, b) the mobile node moves out of the coverage area of one bearer, or c) there is an extraordinary change of traffic condition. Interruption of IP traffic flow should be avoided, if possible. This is particularly important with IP packets having high QoS requirements. Inversely, flows with low QoS requirements should be interrupted first, if interruptions cannot be avoided. Obeying these principles allows the use of the same interface unit as long as possible.

Reference:

1. MEMO network documentation at http://memo.lboro.ac.uk

CLAIMS

1. A method for sending a data packet (DP), which directly or indirectly indicates a quality-of-service requirement (QoS), to a mobile node (MN) from the mobile node's correspondent node (MCN) via a multi-bearer network, or MBN, wherein the MBN provides:

at least one interface unit (IU) to each of multiple alternative bearer networks (BN) between the MBN and the mobile node;

a mobility management function (MMF) to maintain mobility data related to the mobile node (MN);

the method being characterized by the steps of:

selecting an optimal bearer network (BN) for sending a data packet (DP) between the MBN and the mobile node (MN) based on:

the quality-of-service requirement (QoS) of the data packet (DP) in question;

traffic load data (41) related to the multiple bearers;

interface unit preference information (PIU, 42); and

bearer type preference information (PBT, 43).

2. A method according to claim 1, characterized by combining said traffic load data (41), said interface unit preference information (PIU, 42) and said bearer type preference information (PBT, 43) into a data structure (MBRT) which functionally corresponds to a two-dimensional table, each entry of which directly indicates an interface unit (IU) for a combination of a subscriber and a quality-of-service requirement (QoS).

3. A method according to claim 1 or 2, characterized in that the bearer type preference information (PBT, 43) indicates, at least for some values of the quality-of-service requirement, multiple preferred bearers and their rank of preference.

4. A method according to any one of the preceding claims, characterized in that the interface unit preference information (PIU, 42) indicates, at least for some bearer types, multiple preferred interface units and their rank of preference.

5. A method according to any one of the preceding claims, characterized in that the bearer type preference information is configurable by the operator of the MBN.

6. A method according to any one of the preceding claims, characterized in that said bearer networks (BN) provide at least a first set of point-to-point bearers and a second set of multicast or broadcast bearers, and the step of sending a data packet comprises sending at least some data packets encrypted via a bearer of said second set and sending a corresponding decryption key to at least one intended recipient via a bearer of said first set.

7. A method according to claim 2, characterized in that each entry of said data structure (MBRT) also indicates whether the entry in question has been used during a predetermined time interval.

8. A network element (VAS) for a multi-bearer network, or MBN, the network element comprising a mobility management function (MMF) for a mobile node (MN), the mobile node communicating with its correspondent node (MCN) via the MBN;

wherein the MBN provides at least one interface unit (IU) to each of multiple alternative bearer networks (BN) between the MBN and the mobile node;

characterized by:

a traffic management function (TMF) for selecting an optimal bearer network (BN) for a data packet (DP) between the MBN and the mobile node (MN) based on:

the quality-of-service requirement (QoS) of the data packet (DP) in question;

traffic load data (41) related to the multiple bearers;

interface unit preference information (PIU, 42); and

bearer type preference information (PBT, 43).

9. A network element (VAS) according to claim 8, characterized by being adapted to combine said traffic load data (41), said interface unit preference information (PIU, 42) and said bearer type preference information (PBT, 43) into a data structure (MBRT) which functionally corresponds to a two-dimensional table which directly indicates an interface unit (IU) for each combination of a subscriber and a quality-of-service requirement (QoS).

Fig. 1A

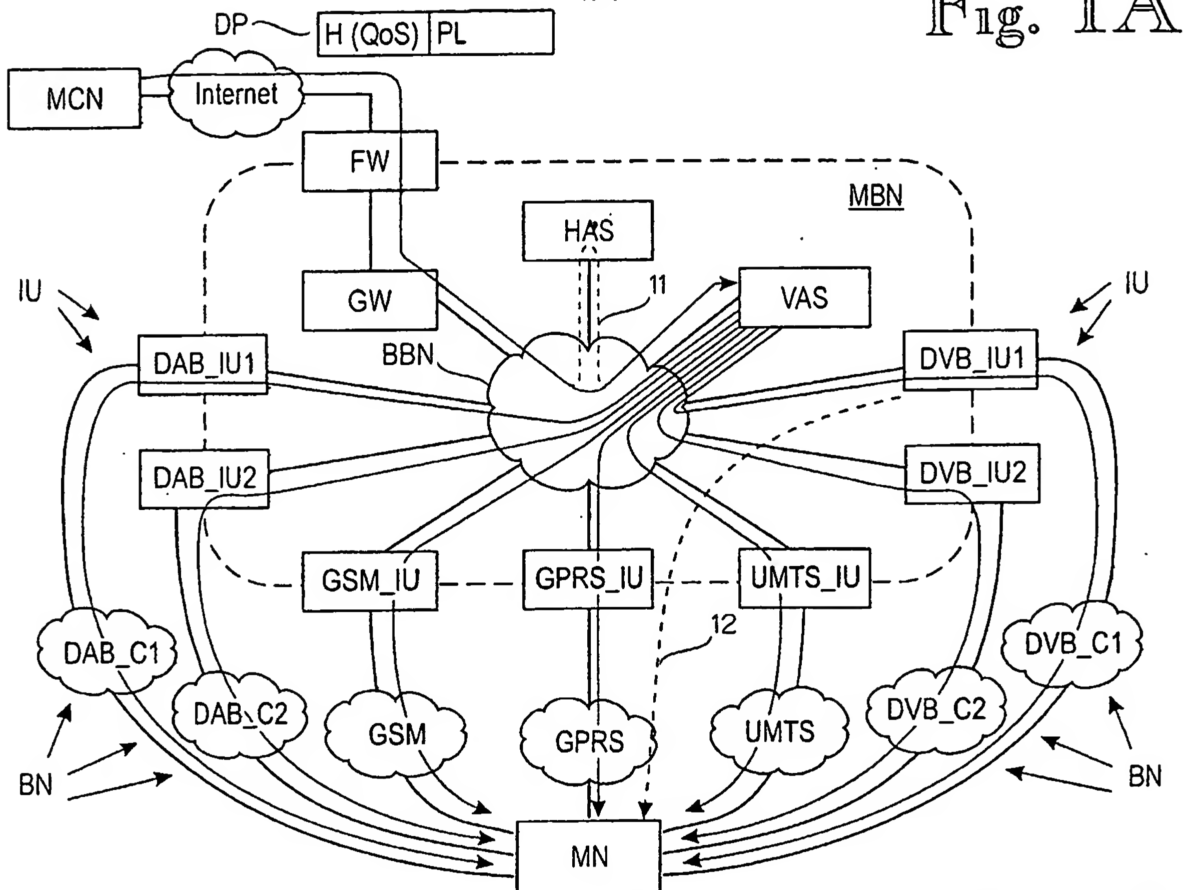
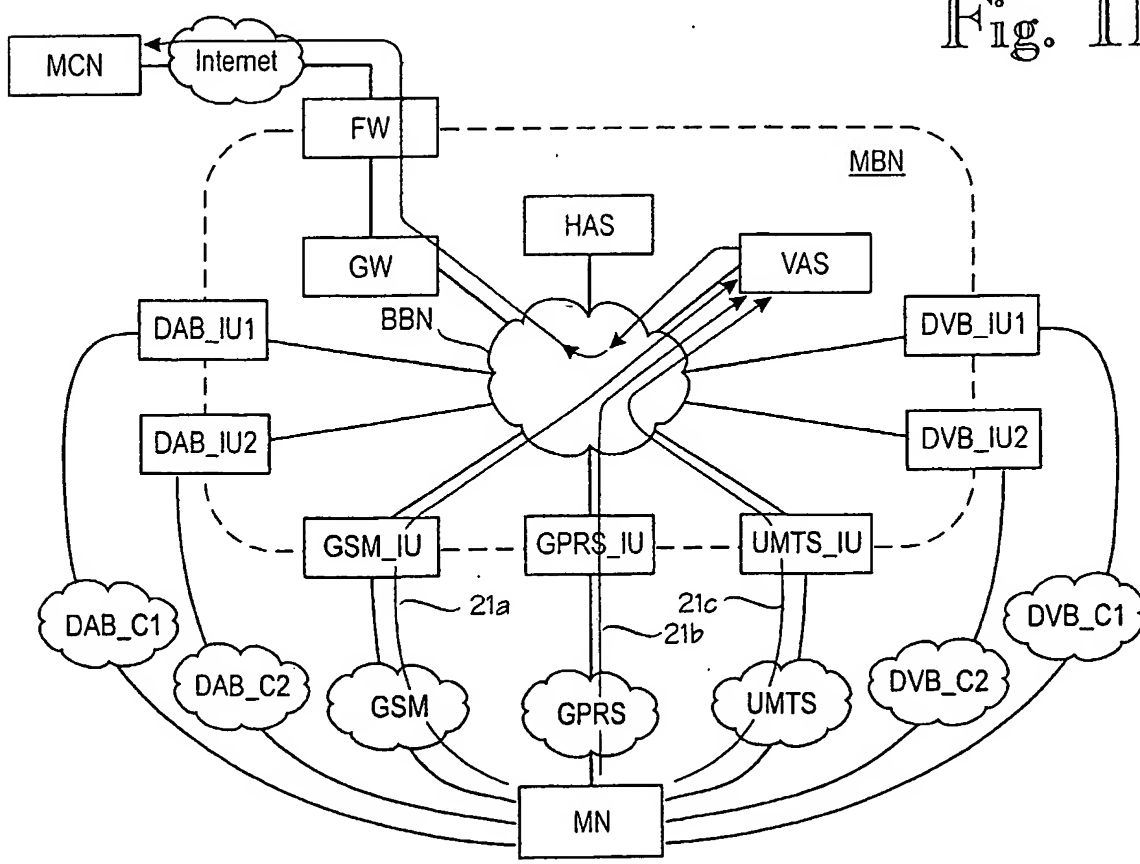

DP
H (QoS)
PL
MCN
Internet
FW
MBN
HAS
11
VAS
GW
IU
IU
DAB_IU1
BBN
DVB_IU1
DAB_IU2
DVB_IU2
GSM_IU
GPRS_IU
UMTS_IU
12
DAB_C1
DVB_C1
DAB_C2
GSM
GPRS
UMTS
DVB_C2
BN
BN
MN

Fig. 1B


MCN
Internet
FW
MBN
HAS
VAS
GW
BBN
DAB_IU1
DVB_IU1
DAB_IU2
DVB_IU2
GSM_IU
GPRS_IU
UMTS_IU
21a
21c
21b
DAB_C1
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GSM
GPRS
UMTS
DVB_C2
MN

Fig. 2

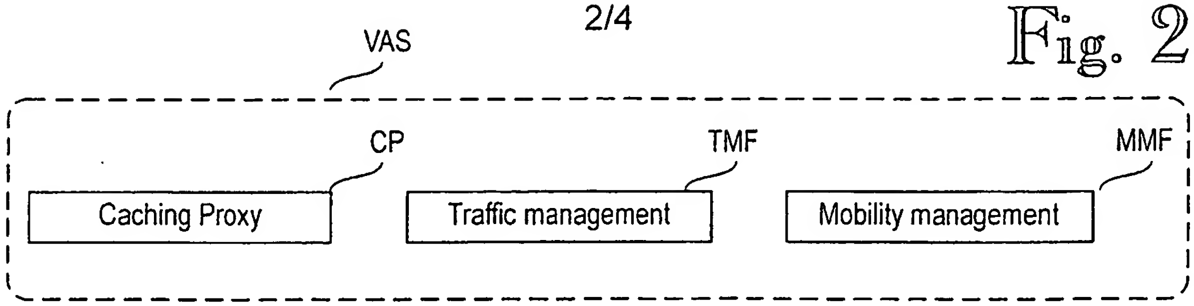


Fig. 3A

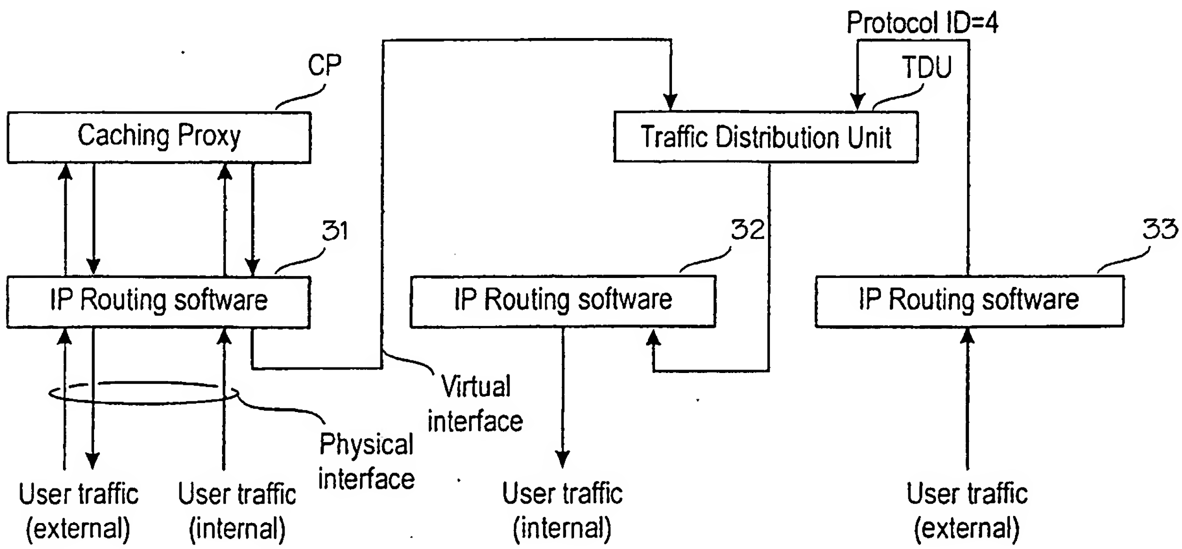


Fig. 3B

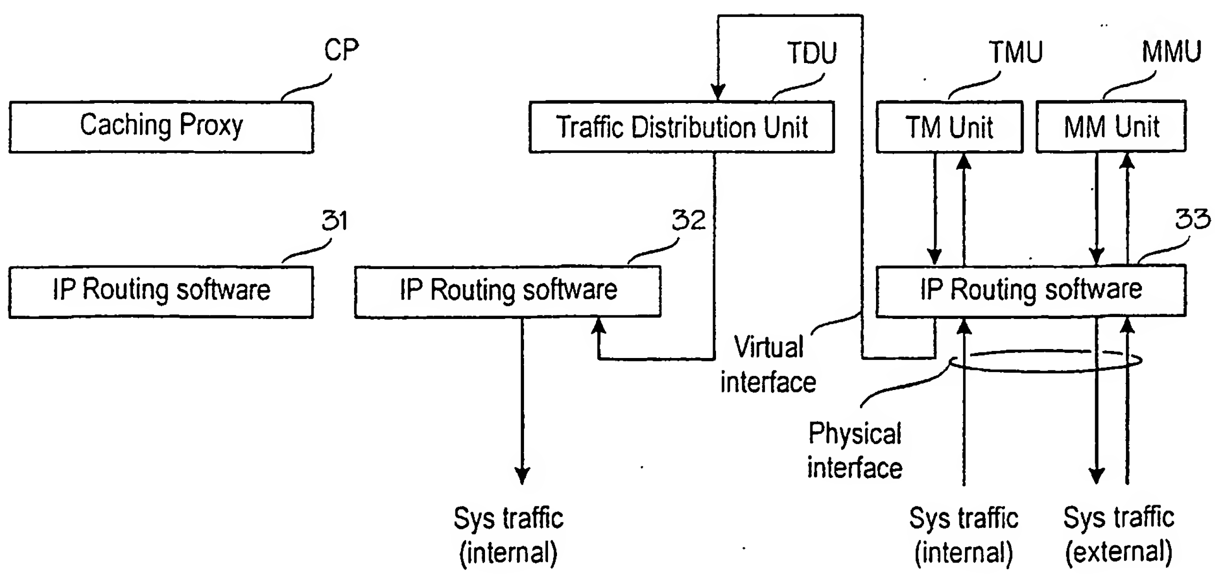
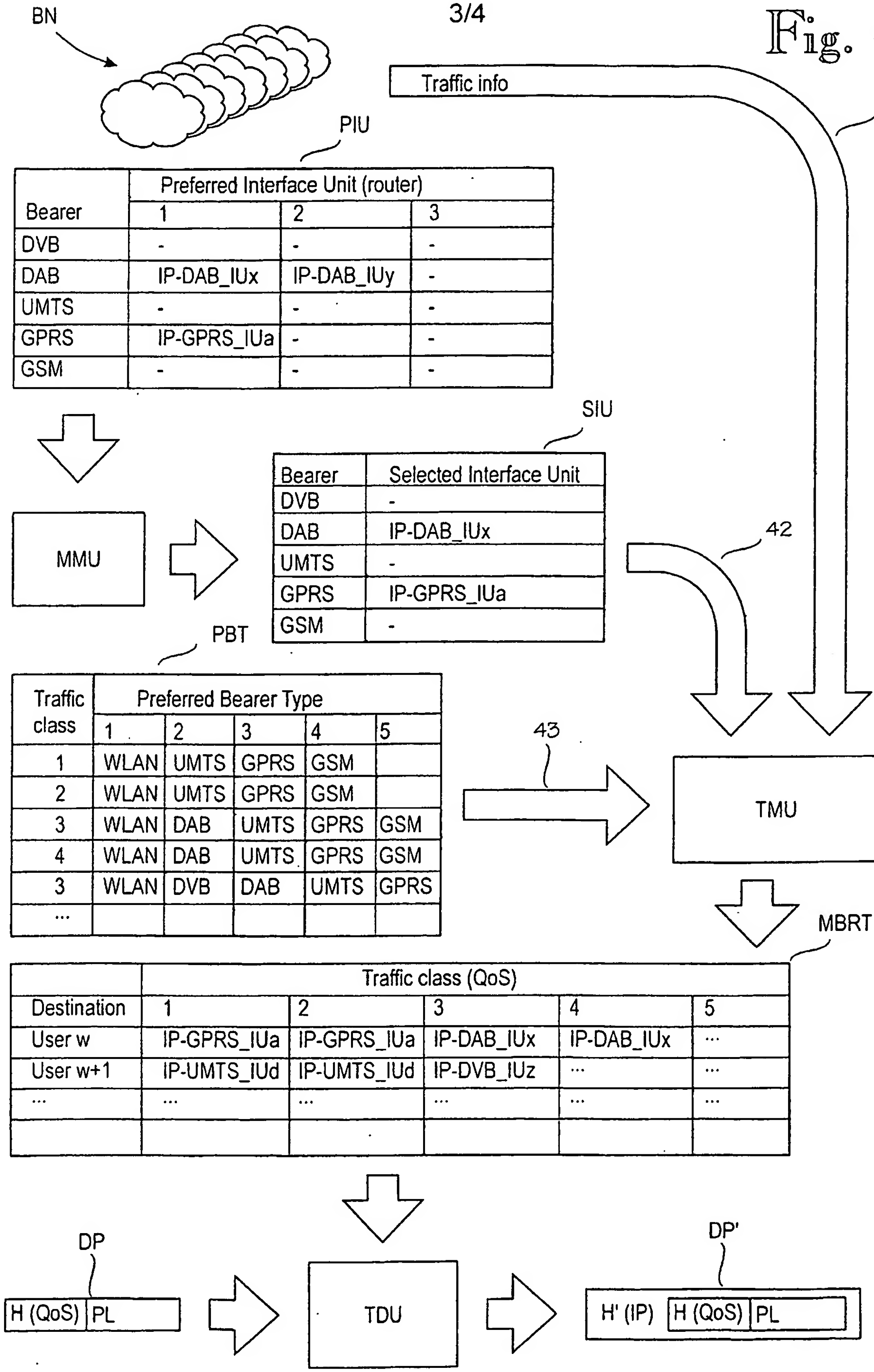


Fig. 4



Bearer	Preferred Interface Unit (router)		
	1	2	3
DVB	-	-	-
DAB	IP-DAB_IUx	IP-DAB_IUy	-
UMTS	-	-	-
GPRS	IP-GPRS_IUa	-	-
GSM	-	-	-

Bearer	Selected Interface Unit
DVB	-
DAB	IP-DAB_IUx
UMTS	-
GPRS	IP-GPRS_IUa
GSM	-

Traffic class	Preferred Bearer Type				
	1	2	3	4	5
1	WLAN	UMTS	GPRS	GSM	
2	WLAN	UMTS	GPRS	GSM	
3	WLAN	DAB	UMTS	GPRS	GSM
4	WLAN	DAB	UMTS	GPRS	GSM
3	WLAN	DVB	DAB	UMTS	GPRS
...					

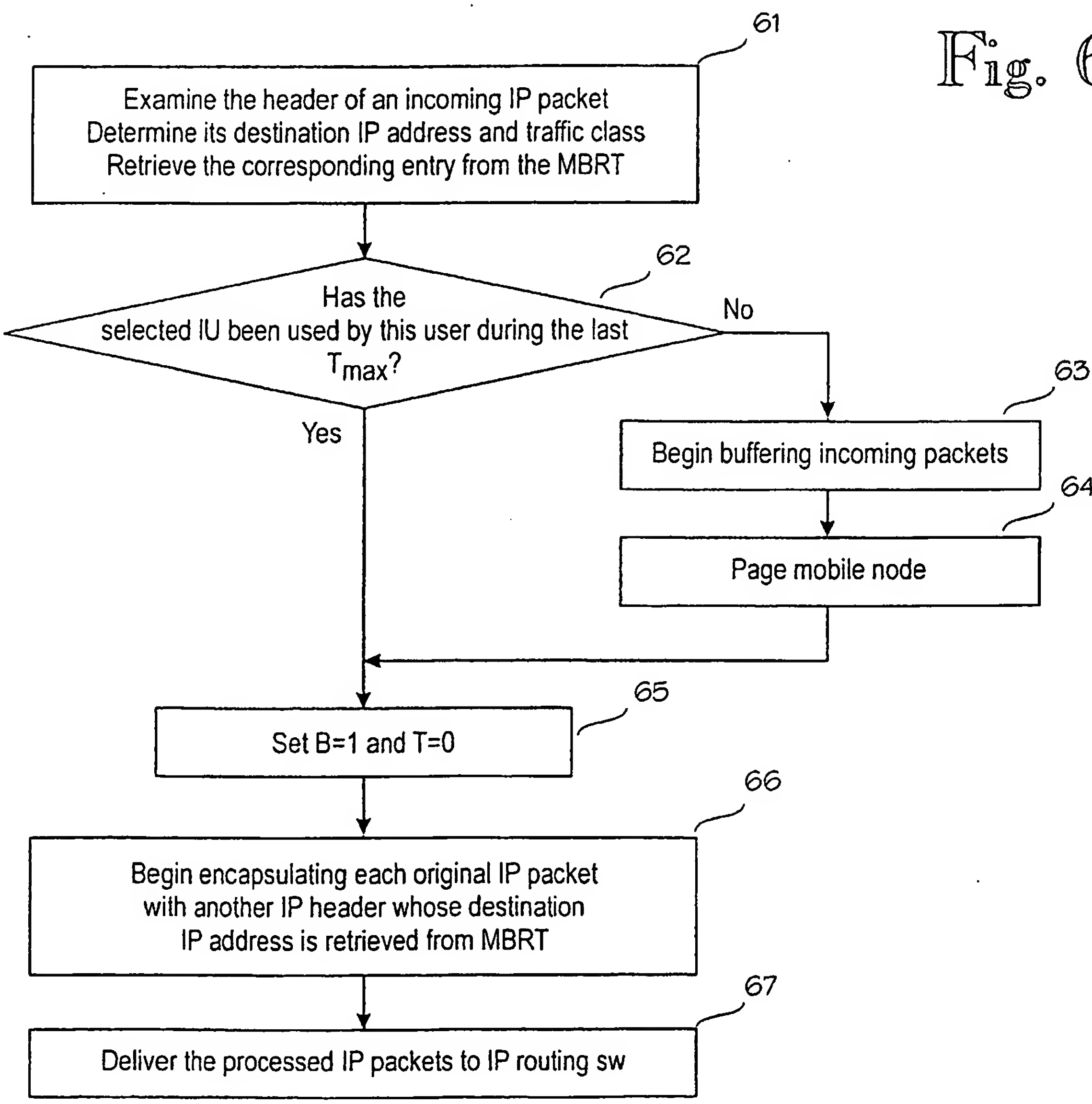
	Traffic class (QoS)				
Destination	1	2	3	4	5
User w	IP-GPRS_IUa	IP-GPRS_IUa	IP-DAB_IUx	IP-DAB_IUx	...
User w+1	IP-UMTS_IUd	IP-UMTS_IUd	IP-DVB_IUz	...	...
...	...	...	...	...	...

Fig. 5

MBRT

	Traffic class (QoS)									
Destination	1		2		3		4		5	
User w	IP-GPRS_IUa		IP-GPRS_IUa		IP-DAB_IUx		...		...	
	B=0	T=14	B=0	T=2	B=1	T=3				
User w+1	IP-UMTS_IUd		IP-UMTS_IUd		IP-DVB_IUz		...		...	
	B=0	T=4	B=1	T=3	B=0	T=3				

Fig. 6



INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 00/01166

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04Q 7/22, H04L 12/56
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04L, H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 9966736 A2 (NOKIA MOBILE PHONES LTD.), 23 December 1999 (23.12.99), page 3, line 1 - page 6, line 22, claims 1-5, abstract	1,3-6,8
A		2,7,9
	--	
Y	WO 9948310 A1 (NOKIA TELECOMMUNICATIONS OY), 23 Sept 1999 (23.09.99), page 15, line 15 - page 16, line 29, claims 1-13, abstract	1,3-6,8
A		2,7,9
	--	

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 April 2001	26 -04- 2001
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Roger Bou Faisal/L Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 00/01166

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9939480 A2 (NOKIA MOBILE PHONES LTD), 5 August 1999 (05.08.99), claims 1-14 --	1-9
A	WO 9952305 A1 (NOKIA TELECOMMUNICATIONS OY), 14 October 1999 (14.10.99), the whole document --	1-9
P,A	WO 0010357 A1 (NOKIA NETWORKS OY), 24 February 2000 (24.02.00), claims 1-18 --	1-9
A	WO 9736405 A1 (NOKIA TELECOMMUNICATIONS OY), 2 October 1997 (02.10.97), claims 1-9, abstract -- --------	1-9

INTERNATIONAL SEARCH REPORT
Information on patent family members

02/04/01

International application No.
PCT/FI 00/01166

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9966736 A2	23/12/99	AU 4784899 A	05/01/00
		FI 981401 A	17/12/99
WO 9948310 A1	23/09/99	AU 2838999 A	11/10/99
		EP 1064800 A	03/01/01
		FI 980617 A	20/09/99
WO 9939480 A2	05/08/99	AU 2166599 A	16/08/99
		EP 1057305 A	06/12/00
		FI 3553 U	31/08/98
		FI 980191 A,V	29/07/99
WO 9952305 A1	14/10/99	AU 2937999 A	25/10/99
		FI 980666 A	26/09/99
WO 0010357 A1	24/02/00	AU 5291899 A	06/03/00
		FI 105969 B	00/00/00
		FI 981722 A	11/02/00
WO 9736405 A1	02/10/97	AU 2162097 A	17/10/97
		CA 2250040 A	02/10/97
		CN 1214832 A	21/04/99
		EP 0886938 A	30/12/98
		FI 103005 B	00/00/00
		FI 961363 A	26/09/97
		JP 2000507416 T	13/06/00